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# TEXAS AGRICULTURAL EXPERIMENT STATION

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

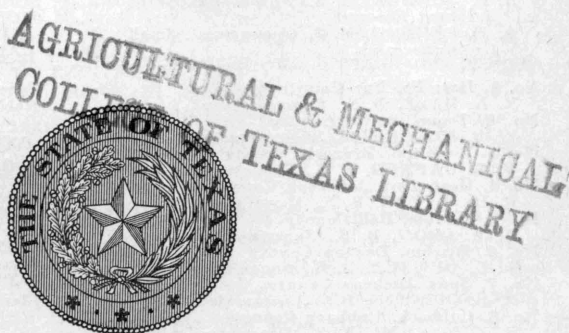
W. B. BIZZELL, President

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DIVISION OF CHEMISTRY

## THE PRICE OF FEED UTILITIES



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COLLEGE STATION, BRAZOS COUNTY, TEXAS

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\*\*\*In cooperation with United States Department of Agriculture.

## SYNOPSIS

The object of this Bulletin is to study the relation between the selling prices of commercial feeds and their content of feed utilities. The prices of pounds of digestible protein, and therms of productive energy, were calculated from certain available feed prices, on pairs of well-known feeds, one high in protein and the other low in protein but high in productive energy. General prices, and prices from Texas, Indiana, and Pennsylvania, were used. The values of various feeds were then calculated from the prices of digestible protein and productive energy and their assumed content of digestible protein and productive energy.

The calculated values were compared with the selling prices of the feeds. With most of the concentrates, the agreement was as close as could be expected, in view of the many factors besides the feeding utility which enter into the selling prices of feeds. Feeders thus appear to have a fairly accurate knowledge of the relative feeding values of well-known feeds, and relative market prices are largely controlled by this knowledge. The values of various concentrates calculated from the digestible protein and productive energy can be used to aid in deciding the most economical feed under given market conditions.

Bulk or volume is an important factor in the price of purchased hay, fodder or roughage, although the farm price of the protein and productive energy is probably much lower in roughage than in concentrates. The measure of bulk is assumed to be 100 less the water and therms of productive energy. The prices of bulk were calculated for wheat bran, oats, alfalfa, cottonseed hulls, and prairie hay.

The method was further applied by calculating the feed costs of pork, beef, and milk, and comparing them with the market prices. There is a considerable margin between the feed cost of milk and its selling price, the margin for pork is much smaller, and with beef it is very small, showing the importance of low-priced roughage for the profitable production of beef under our present conditions. These calculations are merely intended to illustrate the use of the method and more exact comparisons must await a thorough study of the prices to be used and is a subject for agricultural economics rather than chemistry.

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## THE PRICE OF FEED UTILITIES

G. S. Fraps.

The prices of the utilities in feeding stuffs are an important problem that is constantly coming up in different forms. The Feed Control Official is called on to recommend rebates to be paid when feeds do not come up to guaranteed analysis. The chemist and the animal husbandman are called on for information as to the relative money values of different feeds, such, for instance, as corn and barley. Very difficult questions may arise. The cost of feed to produce meat or milk may be studied by means of the prices of the feed utilities.

These and other problems may receive aid in their solution from the study of the cost of feed utilities from the point of view of the chemist.

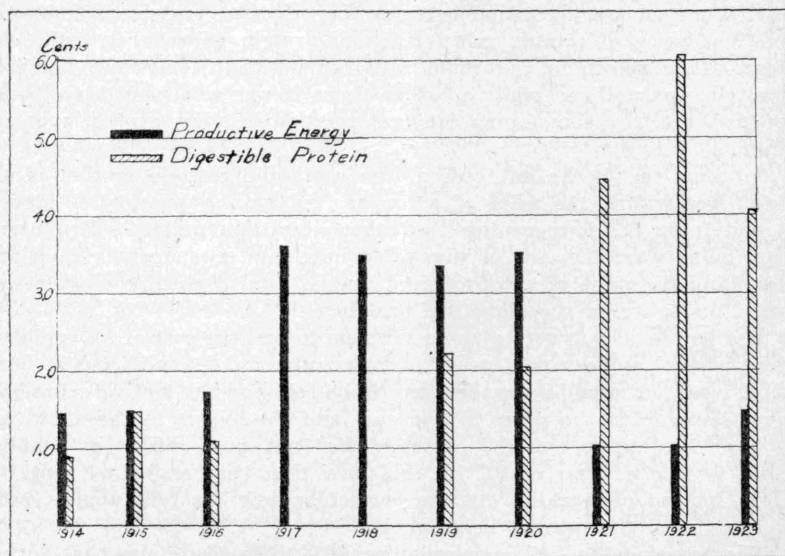


Figure 1—Prices of digestible protein and productive energy in cents a pound.

### Methods Suggested

Several methods have been used for solving some of the problems referred to above. The cottonseed crushers use the protein content alone. If a cottonseed meal is guaranteed 43 per cent. protein, and runs 42 per cent., a rebate of 1-43 of the purchase price is due. Protein is not the only constituent of feeding utility in cottonseed meal, but it is the most important one, and this method is very simple and relatively inexpensive.

Halligan in his *Elementary Treatise on Stock Feeds and Feeding*, and in various bulletins of the Louisiana Experiment Station, uses the following method for calculating rebates from the analysis of the feed:—

One pound of protein is considered to be of the same value as two and one-half pounds of nitrogen-free extract, and one pound of fat is considered to be worth as much as two and one-quarter pounds of nitrogen-free extract. To secure the number of units on which the value is based, multiply the protein content by 2.50, and the fat content by 2.25 and add these products to the nitrogen-free extract content, and the sum is the total unit value of a feed. The selling price of a feed divided by the guaranteed unit value, gives the guaranteed price per unit. The guaranteed price per unit multiplied by the number of units delivered, gives the delivered price. The difference gives the rebate.

A method like the one above described, based upon the chemical analysis alone, would be very desirable if approximately correct. But it is incorrect to assume equality of nitrogen-free extract from different sources, or to fix an arbitrary relation between the prices of protein and non-protein. The price of protein relative to non-protein depends on trade conditions. It is shown in Figures 1 and Table 3 that sometimes the price of protein was nothing, while at other times it was relatively high. Hence it is incorrect to assume some constant relation between protein and non-protein.

In some text-books on feeding, the cost of digestible protein is calculated by dividing the price of a ton of feed by the quantity of digestible protein in it, disregarding the other digestible nutrients or energy. In a similar way, the cost of digestible nutrients or energy is calculated by dividing the price of a ton of feed by the total digestible nutrients, or energy, disregarding the digestible protein.

If a boy in school were given a problem to find the cost of an apple and a pear when 3 apples and 4 pears cost 29 cents, and 5 apples and 11 pears cost 70 cents, he would be graded zero if he followed the method mentioned above, disregarded the pears in one case and the apples in the other, and said that the apples cost 9.2 cents in the first case and 8 cents in the second, while the pears cost 7 1-4 cents the first time and 6 4-7 cents the second, instead of working out the correct answer that the apples cost 3 cents each and the pears 5 cents each.

The same method of calculation would justify the claim that cottonseed meal has nearly six times the value of corn. If corn contains 6.1 per cent. digestible protein and cottonseed meal 36.6 per cent., cottonseed meal has 6 times the value of corn. This calculation, however, is correct only when productive energy has no value, which never occurs, but the method of calculation given in the text-books referred to, give an excuse for drawing such an erroneous conclusion.

### What Constitutes the Feed Utilities

The ordinary chemical analysis of a feed includes the estimation of protein, fat, crude fiber, nitrogen-free extract, water, and ash. Some of these determinations are indicative of the quality of the same kind of feeds and are used in the comparison of the quality of different lots. For example, the protein content of cottonseed meal is used to measure

its commercial value with a fair degree of accuracy. It is not possible, however, to compare cottonseed meal with other feeds on the basis of the protein content. Cottonseed meal cannot be directly compared with corn because other things besides the protein content enter into the value of both feeds.

The ordinary chemical analysis does not, however, show the feed utilities. If the protein of one feed had the same utility to an animal as the protein of any other feed, and if the fat, crude fiber, and nitrogen-free extract of one feed had the same utility as the fat, crude fiber, and nitrogen-free extract of any other feed, the analysis of a feed would show its value compared with any other feed, but such is not the case. Each of these determinations is a group of substances, not definite substances in themselves, and their nature varies with different feeds. The protein of one feed is different in digestibility and in feeding utility from the protein of other feeds, and the same holds true with respect to the nitrogen-free extract, fat, and fiber. Any method of comparing different kinds of feeds by the chemical analysis alone is erroneous.

It might be possible to assume that the digestible constituents could be used to measure feeding utility. It could be assumed that the digestible protein of one feed is equal in feeding utility to the digestible protein of any other feed, and that the digestible nitrogen-free extract of any one feed is equal in feeding utility to the digestible nitrogen-free extract of any other feed, and likewise with the other constituents. The assumption of the equality in feeding utility of digestible nutrients was made for a good many years, and is still being used by practically all books on animal feeding, but it is not correct. In calculating rations for feeding, the assumption is generally made that one pound of digestible nitrogen-free extract in one feed is as good as one pound in any other feed, and so on for the other groups of nutrients. This assumption has been tested and found to be incorrect. The investigations of Kellner and of Armsby have proved that the digestible constituents of one kind of feed are generally different in value from those of another. For example, one pound of digestible nutrients in corn is equal to five pounds of digestible nutrients of some hays. There are always great differences in the utility of the digestible constituents of concentrates as compared with roughages. In the light of this knowledge, it is incorrect to assume that the digestible nutrients of different feeds are equal in utility.

Feeding utilities consist of digestible protein, productive energy, bulk, vitamins, and other factors.

### Digestible Protein and Productive Energy

Most of the feed digested by an animal is used in two ways. Part of it is used for material to build and repair tissue and to form secretions, and part of it is used for energy to keep the animal warm, to carry out life processes, for bodily movements, for work, or to be stored up as fat, or to be secreted as milk.

Digestible protein is used for the purpose of repairing animal tissues,

forming the digestive juices, and other secretions, building new tissues, producing hair, bone, and milk, and so on. It can also be used for fat or energy. It is a well known fact that the digestible protein of different feeds is different in character, but it is not yet known to what extent this influences the feeding utility of the different feeds. Our knowledge so far chiefly emphasizes the importance of using a variety of feeds in the ration, and of exercising special care in feeding mixtures of certain feeds. We still have a great deal to learn with respect to the differences in the feeding utility of the proteins of various feeds.

The productive energy of a feed, expressed in therms or fat, measures its power of furnishing heat or energy to the animal, or of furnishing material or energy for the production of fat, or for work or for other uses to which material or energy is put. Methods for the calculation of the productive energy have been devised by Kellner, and by Armsby, and have been published in their books and elsewhere. Bulletin 185 of this Station contains a brief discussion of the matter, and also contains production coefficients for easily calculating productive energy.

### Other Feed Utilities

There are other elements which enter into the utility of feed in addition to the digestible protein and the productive energy, though these two are probably the most important.

The volume or mere weight of roughage is no doubt one of the feed utilities when roughages are purchased and is probably next in importance after digestible protein and productive energy, from the point of view of money cost. Cows, horses, and similar animals need rations with a proper bulk or volume, which is secured by using hays, fodders or other roughages. The cost of protein and productive value is less in grasses and fodders when they are pastured than in concentrated feeds. A committee of the American Society of Agronomy estimates that over half the feed of cattle is furnished by pasturage and that pasturage costs only about one-fourth as much as harvested forage (Science News Service, Science, Dec. 14, 1923). Farmers often have more roughage than they need, and such roughage is a cheap feed.

But when roughage is harvested, shipped, and sold, it often costs more in proportion to its digestible protein and productive energy than concentrated feeds, so that purchasers pay a price for bulk or volume. In bulky feeds, transportation, storage and handling charges, which are in proportion to weight, are high for each unit of feeding utility. Thus while feeding utilities in roughages on the farm may cost less than in concentrates, especially when pastured, feeding utilities in roughages when purchased by dairymen, and owners of work animals or any one else who buys roughage, may cost more than in concentrates. To put it another way, farmers or stockmen who produce their own roughages, may pay nothing for bulk, while those who buy roughages usually pay for bulk.

Other feed utilities are differences in the utility of protein from different sources, content of vitamins, amount and composition of ash, and



possibly others. We are not yet sufficiently informed concerning the differences that exist between the proteins, vitamins, or ash ingredients in various feeds, and the importance of these deficiencies, to base any difference in value upon any of them.

### **Basis for Calculating Prices of Digestible Protein and Productive Energy**

The first object of the present study is to ascertain to what extent the content of digestible protein and productive energy may be related to the relative prices of the feeding stuffs on the market.

The costs of digestible protein and productive energy are based upon the contents of the feed in these elements of utility, and the selling prices of the feed. The selection of feeding utilities and prices to be used are both a matter of difficulty. The prices of feeds depend upon many conditions, which it is beyond the object of this Bulletin to discuss. The farm prices are, of course, lower than the wholesale prices, for the cost of handling, and transportation must be added to the farm prices. The retail prices, again, must carry further handling and transportation charges, and are still higher than the wholesale prices.

Farm prices, wholesale prices, and retail prices vary from section to section, and from time to time, according to distances from centers of production, supply, demand, and other conditions. All these variations are matters beyond the scope of this bulletin to discuss. For the purpose of this work, certain available market prices were selected with the object of comparing the particular feeds at that particular time.

For general prices we have used the wholesale prices from 1913 to 1920 published in the Report of the Federal Trade Commission on Commercial Feeds March 29, 1921. These are wholesale prices paid on large markets. For 1921, 1922 and 1923 the prices on the Kansas City market about March 23 were used. The Pennsylvania and Indiana prices are those published in the Feed Control bulletins of the Pennsylvania Department of Agriculture, and of the Indiana Experiment Station. The Texas prices were compiled from various sources. The Pennsylvania, Indiana, and Texas prices represent approximately the retail prices, while the other figures represent approximately wholesale prices. The prices assumed are given in Table 1. These prices are selected for the purpose of comparing the different feeds at the same time, and not for comparing prices under different sets of conditions.

The costs of digestible protein and productive energy were calculated from the market prices of two feeds, one high in protein and the other low in protein, both being high in productive energy. The feeds selected should be in general use, well known and of high utility. They should have been in use for a long time, so that feeders should be well acquainted with their feeding value through practical experience. The feeds selected for the Northern and Central States were corn, or corn feed meal, and linseed meal; for Texas, corn and cottonseed meal.

The chemical composition of feeds varies considerably. The average



composition was taken as a basis for the comparison, and not the minimum guarantee required by the various Feed Control officials. The average composition for Pennsylvania, Indiana, and Texas was made up from the averages reported in the Feed Control bulletins of these States, for the period of years considered. The average composition of the other feeds was made up in the same manner. The author used his discretion in selecting the averages which appeared most probable.

Table 1—Assumed selling prices, per ton, used in calculations.

	Wholesale		Pennsylvania		Indiana		Texas	
	Corn	Linseed Meal	Corn Feed Meal	Linseed Meal	Corn Feed Meal	Linseed Meal	Corn Chops	Cottonseed Meal
1914 .....	\$24.96	\$28.73	\$32.72	\$40.61	\$29.30	\$39.26	\$30.00	\$27.00
1915 .....	26.23	33.11	—	—	31.11	42.73	—	—
1916 .....	29.58	34.22	—	—	31.96	41.56	—	—
1917 .....	59.01	48.02	66.60	57.33	59.42	56.51	—	—
1918 .....	57.37	54.73	68.00	63.05	61.80	66.58	70.00	58.00
1920 .....	60.99	72.70	69.67	85.92	63.01	83.14	49.60	44.50
1921 .....	22.00	45.00	—	—	28.60	50.91	45.20	42.30
1922 .....	24.00	55.50	—	—	—	—	32.50	51.20
1923 (Jan.) .....	29.00	49.50	—	—	—	—	38.20	50.25
1923 (Mar.) .....	—	—	—	—	—	—	40.00	54.00
1924 (Jan.) .....	—	—	—	—	—	—	38.00	42.00

The digestible protein was calculated from the chemical composition and the coefficients of digestibility. The productive energy which is expressed in therms, was calculated by the use of production coefficients. (See Bulletin 185). Coefficients of digestibility and production coefficients were taken from tables compiled and calculated at this Experiment Station, but not yet published.

Table 2—Assumed percentage composition, digestible protein and productive energy in therms used in calculating prices of protein and productive energy.

	Protein	Ether Extract	Crude Fiber	Nitrogen-free Extract	Water	Ash	Productive Energy Therms	Digestible Protein Pounds	K (factor)
Trade Commission—Corn .....	9.5	4.3	2.0	67.0	15.0	1.2	82.2	6.1	.002275
Trade Commission—Linseed meal ..	36.9	7.0	8.4	35.7	8.0	5.0	79.0	32.6	—
Pennsylvania—Corn feed meal ....	10.1	5.3	3.2	68.9	11.0	1.5	87.8	5.9	.002203
Pennsylvania—Linseed meal .....	35.0	6.8	7.9	36.4	9.5	4.4	77.4	31.0	—
Indiana—Corn feed meal .....	9.2	4.3	2.5	71.2	10.8	1.8	86.2	5.9	.002307
Indiana—Linseed meal .....	34.4	7.1	8.3	37.3	7.9	5.2	78.3	30.5	—
Texas Corn chops .....	9.5	4.3	2.0	67.0	15.0	1.2	82.2	6.1	—
Texas—Cottonseed meal before 1913	45.0	8.7	9.0	25.0	7.0	5.3	77.4	39.0	.001829
Texas—Cottonseed meal after 1913..	43.7	7.6	10.4	25.5	7.3	5.5	73.9	37.9	.001877

The average composition, digestible protein, and productive energy used are given in Table 2.

### Method of Calculating Prices of Protein and Productive Energy

The difficult part of this work is to decide upon the composition and prices of the feeds to be used. Once the prices and composition have been

decided upon, the calculation of the prices of digestible protein and productive value is a simple matter.

Let  $a$ =price of carbohydrate feed A in dollars per ton.  
 $b$ =price of protein feed B in dollars per ton.  
 $p$ =pounds digestible protein in 100 pounds feed A.  
 $t$ =therms productive energy in 100 pounds feed A.  
 $n$ =pounds digestible protein in 100 pounds feed B.  
 $c$ =therms productive energy in 100 pounds feed B.  
 $x$ =price of digestible protein in one pound.  
 $y$ =price of productive energy in cents per therm.

Then  $20px + 20ty = a$  Equation 1.

$20mx + 20cy = b$  Equation 2.

Solving  $x = \frac{(tb - ca) 100}{(nt - pc) 20}$  Equation 3.

$y = \frac{(na - pb) 100}{(nt - pc) 20}$  Equation 4.

The values of  $x$  and  $y$  can be calculated for any given composition and prices. It should be noted that the fraction

$k = \frac{100}{(nt - pc) 20}$  Equation 5

is constant for any two feeds of constant composition, and may conveniently be calculated when it is to be used a number of times. The equations then become:—

$y = (tb - ca) K$  Equation 6.

$y = (na - pb) K$  Equation 7.

Table 1 shows the values for  $K$  used. For any value of (a) the price of feed A, there is a corresponding value for (b) the price of feed B, at which (x) the cost of digestible protein is zero, and another value at which (y) the cost of productive value is zero.

If  $x$  is 0, from equation 6,  $b = \frac{ca}{t}$  Equation 8.

If  $x$  is 0, from equation 7,  $b = \frac{na}{p}$  Equation 9.

If we use the feeds for Texas and take corn at \$20.00 a ton, cottonseed meal would have a calculated value of \$17.98 a ton, when digestible protein is zero, or, to put it another way, if cottonseed meal in Texas

sells at 90% of the price of corn, or less, digestible protein costs nothing. In such event, cottonseed meal can be fed on the basis of its productive energy alone, and such has been the case at times. (Even in October 1924).

If corn is taken at \$20.00 a ton, and the productive energy at zero, cottonseed meal would have a calculated price of \$130.00 a ton. This relation has never occurred, and is not likely to occur.

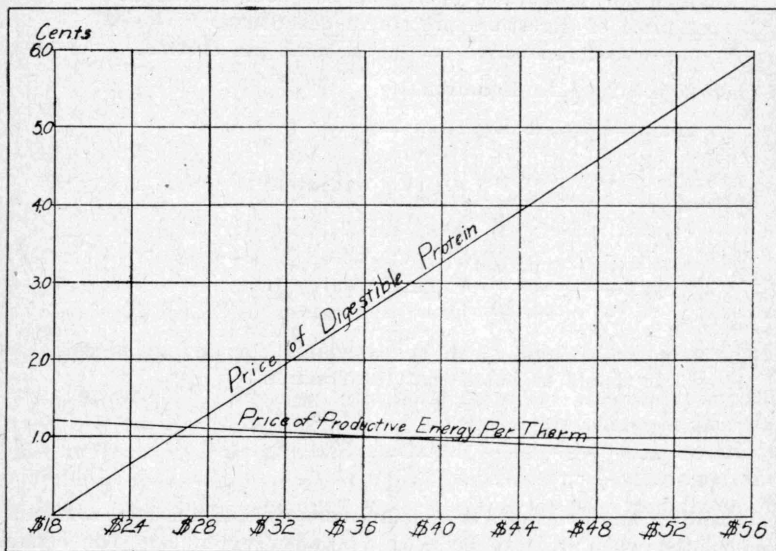


Figure 2—Prices of pounds digestible protein and therms of productive energy with corn at twenty dollars a ton and Texas cottonseed meal at the prices given.

### Calculating Chart

The prices of protein and productive value may be plotted as straight lines when the price of one feed is taken as unity, by using the relative price of the other feed as an ordinate and the values of x or y as abscissa. Figure 2 shows the prices of pounds of digestible protein and therms of productive energy when corn is taken at \$20.00 a ton and Texas cottonseed meal at the relative prices given. A similar chart could be prepared for any sets of two feeds, and could be used for calculating the prices of digestible protein and productive energy at any prices given for the two feeds of the assumed composition.

### The Prices of Digestible Protein and Productive Energy

The relative prices of digestible protein and productive energy calculated from the data given in Tables 1 and 2 is given in Table 3. The value of digestible protein would be negative in some cases if the method were strictly followed. It is hardly probable that digestible protein could

have a value less than nothing; so in these cases it is put down as zero, and the productive energy calculated with digestible protein having no value. The figures for Texas 1923 are the averages for January and March.

Table 3—Comparative prices of therms of productive energy and pounds of digestible protein in cents.

	Productive Energy Therms				Digestible Protein, Pounds			
	U. S. Wholesale	Pennsylvania	Indiana	Texas	U. S. Wholesale	Pennsylvania	Indiana	Texas
1914 .....	1.45	1.71	1.53	1.83	.89	2.28	2.52	0
1915 .....	1.43	—	1.61	—	1.46	—	2.38	—
1916 .....	1.72	—	1.68	—	1.08	—	2.49	—
1917 .....	3.53	3.77	3.41	—	0	0	0.50	—
1918 .....	3.43	3.84	3.44	4.25	0	.60	2.07	0
1919 .....	3.35	4.23	3.58	3.73	2.20	1.60	2.33	2.25
1920 .....	3.51	3.09	3.30	3.02	2.63	4.74	5.15	0
1921 .....	1.01	—	1.32	2.73	4.46	—	4.95	0.26
1922 .....	1.01	—	—	1.73	6.07	—	—	3.39
1923 .....	1.47	—	—	2.18	4.05	—	—	2.61
1924 .....	—	—	—	2.22	—	—	—	1.21

The wholesale price of productive energy reaches a maximum in 1917, varies little from this maximum in 1918, 1919, and 1920; then drops in 1921. The maximum retail prices occur in 1919 for Pennsylvania and Indiana, 1918 for Texas, being one or two years later than the maximum wholesale price. They likewise drop in 1921, but not to as great an extent as the wholesale prices, especially in Texas. This is perhaps caused by higher freight rates and greater expense of handling due to higher wages.

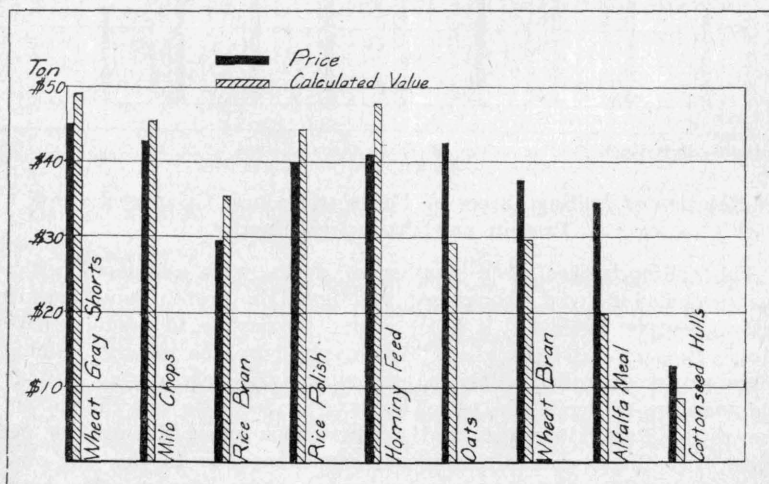


Figure 3—Average relation of selling prices of feeds in Texas to values calculated from digestible protein and productive energy.

The price of digestible protein varies in an entirely different manner from the price of productive energy. Digestible protein costs nothing wholesale in 1917 and 1918, at a time when the price of productive energy reached a maximum for the periods studied. This means that the price of cottonseed meal or linseed meal at that time was just equal to the price of its productive energy. Linseed meal was selling for less than corn. Government regulation possibly had something to do with this.

The price of protein began to go up in 1919, and reached a maximum in wholesale cost in 1922, when it began to fall again. This increase in the cost of protein was caused not by prices of linseed meal and cottonseed meal going up, but by prices of corn coming down. The prices of both linseed meal and cottonseed meal went down, but they did not go down so much as the price of corn. It is the relative prices of corn and of the protein concentrates which govern the cost of digestible protein.

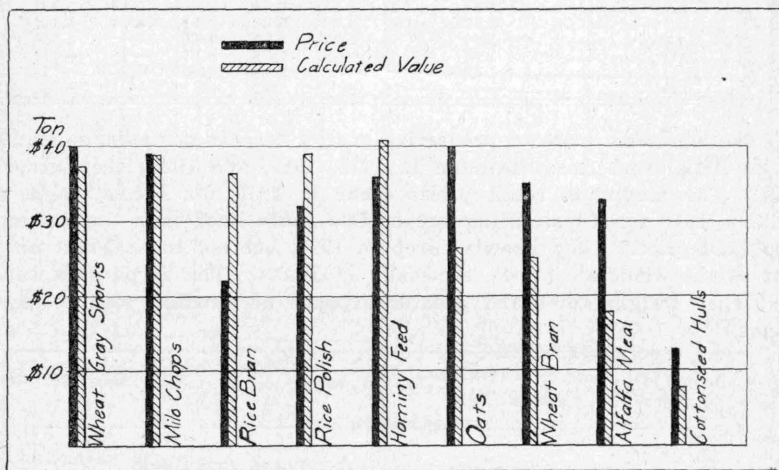


Figure 4—Relation of selling prices of Texas feeds in Jan., 1924, to values calculated from digestible protein and productive energy.

#### Relation of Selling Prices of Feeds to Values, Calculated From Protein and Productive Energy.

The selling prices of a number of feeds were compared with the values calculated from the prices of digestible protein and productive energy given in Table 3. It is of course impossible to assume that the selling prices of a feed are entirely governed by the general opinion of feeders as to its value. This is particularly the case during periods of rapid increase or decline in price, because all feeds do not change at the same rate. Rapid increases and declines took place during the period studied, and there were also unusual conditions due to the war and its after effects. These factors render more obscure the relation between selling prices and feeding value.



There are also local conditions which affect prices, such as distance from center of production, relative demand or scarcity, and so on. For example, milo usually sells for less than corn, but there was a short crop in 1922, and it sold for more than corn for a time.

Table 4—Assumed average composition, productive energy and digestible protein of the feeds used.

	Protein	Ether Extract	Crude Fiber	Nitrogen- Free Extract	Productive Energy Therms	Digestible Protein Pounds
Alfalfa meal (Trade Commission) .....	14.8	2.3	30.0	37.1	37.6	11.1
Alfalfa meal (Penn. 1909-19) .....	15.1	2.1	28.7	36.5	37.3	11.3
Alfalfa meal (Indiana 1913-22) .....	15.3	1.9	28.6	36.9	38.2	11.5
Alfalfa meal (Texas) .....	14.3	1.7	30.9	36.4	34.9	10.1
Beet pulp (Penn. 1909-15) .....	9.2	1.2	18.2	58.0	67.3	4.6
Beet pulp (Penn. 1915-20) .....	10.1	0.9	17.9	58.6	68.1	5.0
Brewers grain (Penn. 1909-20) .....	26.5	7.1	14.3	41.4	43.5	21.5
Corn germ meal (Indiana 1913-22) .....	20.0	10.0	6.8	51.8	89.6	15.3
Corn gluten feed (Indiana 1913-19) .....	26.3	3.3	7.2	50.9	78.2	22.3
Corn gluten feed (Trade Commission) .....	20.0	4.0	7.0	55.0	70.5	17.0
Cottonseed, cold pressed (Indiana 1914-19) .....	25.5	9.5	20.1	33.0	68.6	20.4
Cottonseed hulls (Texas) .....	4.1	0.7	49.2	32.9	17.5	0.0
Cottonseed meal to 1916 (Trade Com.) .....	41.2	8.0	9.0	26.5	73.3	35.7
Cottonseed meal 1916-20 (Trade Com.) .....	37.0	7.0	12.0	28.5	68.3	32.0
Cottonseed meal (Penn. to 1915) .....	41.0	8.2	9.1	28.2	74.7	35.5
Cottonseed meal (Com. Penn. 1915-20) .....	41.7	7.2	11.1	26.5	71.7	36.1
Cottonseed meal (Indiana) .....	40.4	7.4	9.9	28.0	69.0	35.0
Gluten feed (Penn. to 1915) .....	25.4	3.8	6.8	53.0	80.0	21.5
Gluten feed (Penn. 1915-20) .....	26.2	2.8	6.9	53.0	79.0	22.2
Hay, prairie, (Texas) .....	4.0	2.1	29.7	47.2	30.0	0.5
Hominy feed (Trade Commission) .....	9.5	6.0	7.0	62.0	82.0	6.4
Hominy feed (Penn. 1909-15) .....	11.2	8.0	4.2	64.0	91.9	7.5
Hominy feed (Penn. 1916-20) .....	11.6	6.7	4.2	65.0	89.8	7.5
Hominy feed (Indiana) .....	11.1	7.5	4.3	65.7	90.5	7.5
Hominy feed (Texas) .....	10.2	7.3	6.8	62.5	86.3	6.9
Milo chops (Texas 1911-22) .....	10.9	2.9	2.5	71.1	83.1	8.4
Oats (Trade Com. & Texas) .....	11.8	4.2	11.4	57.0	54.6	8.9
Rice bran (Texas) .....	12.4	12.4	12.9	42.0	64.4	8.4
Rice Polish (Texas) .....	12.3	10.6	3.0	58.6	83.5	7.6
Wheat bran (Trade Com.) .....	16.0	4.2	9.5	53.0	48.9	12.5
Wheat bran (Penn. 1909-20) .....	16.2	4.9	9.3	53.6	50.1	12.7
Wheat bran (Indiana 1913-17) .....	16.0	4.0	7.8	56.5	50.3	12.5
Wheat bran (1911-22 Texas) .....	16.8	3.9	9.4	53.5	49.2	13.1
Wheat (flour) middlings (Penn. 1909-19) .....	17.4	5.0	5.3	57.8	76.2	14.6
Wheat (flour) middlings (Indiana 1913-17) .....	16.2	4.2	3.9	61.7	75.7	13.6
Wheat gray shorts (1917-22 Texas) .....	18.3	4.4	5.6	57.7	75.8	15.4

Table 4 contains the composition and productive energy of the feeds used.

Tables 6, 7, 8, 9 contain comparisons of the average selling prices and the money values calculated from the assumed digestible protein and productive energy. Table 5 contains the averages of the figures contained in Tables 6, 7, 8, 9. The averages in Table 5 should be used only for comparing selling prices with calculated prices. The different sets of figures are for different periods of time, and for this reason should not be compared with one another. For example, the selling price of wheat bran may be compared with its calculated value, but the selling price in Indiana should not be compared with the selling price in Texas or Pennsylvania, since the periods included in the averages are different.

Table 5—Average selling prices per ton and calculated value from protein and productive energy for the periods studied.

	Trade Commission	Indiana	Pennsylvania	Texas
Oats— Price .....	\$ 38.12	—	—	\$ 42.45
Calculated .....	28.39	—	—	29.10
Wheat bran— Price .....	28.97	26.29	42.19	37.44
Calculated .....	26.46	22.26	35.55	29.71
Hominy feed— Price .....	41.30	42.69	52.82	41.12
Calculated .....	42.60	45.02	55.44	47.90
Corn gluten feed— Price .....	36.69	38.40	52.54	—
Calculated .....	39.06	43.85	57.32	—
Corn germ meal— Price .....	—	45.82	—	—
Calculated .....	—	51.45	—	—
Alfalfa meal— Price .....	24.72	41.21	47.04	34.40
Calculated .....	21.20	22.25	27.52	19.67
Cottonseed meal— Price .....	40.81	47.82	59.79	—
Calculated .....	42.01	53.26	61.09	—
Wheat middlings or gray shorts— Price .....	—	29.65	47.15	45.09
Calculated .....	—	31.73	49.96	44.09
Beet pulp— Price .....	—	—	47.43	—
Calculated .....	—	—	41.52	—
Brewers grains— Price .....	—	—	50.30	—
Calculated .....	—	—	36.64	—
Milo chops— Price .....	—	—	—	42.57
Calculated .....	—	—	—	45.34
Rice bran— Price .....	—	—	—	29.54
Calculated .....	—	—	—	35.34
Rice Polish— Price .....	—	—	—	39.92
Calculated .....	—	—	—	44.40
Cottonseed hulls— Price .....	—	—	—	12.75
Calculated .....	—	—	—	8.41
Prairie hay— Price .....	—	—	—	24.50
Calculated .....	—	—	—	14.57

If the calculated values of certain feeds agree with the selling prices, within the limit of error, two conclusions may be drawn. One conclusion is that the digestible protein and productive energy represent practically all the feed utility of the feed in question. The values of such feeds may then be compared by means of their digestible protein and productive energy, and the analysis and the production coefficients may be used as means of judging whether the feed in question is selling at higher or lower prices than is justified by the prices of other feeds.

Table 6—Selling prices per ton and calculated values. Trade Commission wholesale prices.

	Oats		Wheat Bran		Hominy Feed		Corn Gluten Feed		Alfalfa Meal		Cottonseed Meal	
	Cost	Calculated	Cost	Calculated	Cost	Calculated	Cost	Calculated	Cost	Calculated	Cost	Calculated
1913	\$23.48	\$15.63	\$18.63	\$14.75	\$21.66	\$22.31	\$20.96	\$21.09	\$17.97	\$11.58	\$25.63	\$24.91
1914	26.21	17.44	21.34	16.43	24.90	24.96	23.38	23.50	17.04	12.90	24.98	27.63
1915	30.68	18.82	20.36	18.18	26.05	26.24	22.08	25.91	15.92	14.41	25.40	32.19
1916	28.85	20.70	20.98	19.52	27.53	29.56	23.51	27.92	17.19	15.33	30.73	32.93
1917	39.97	33.17	32.94	29.71	49.84	58.66	38.06	50.44	27.96	26.90	40.41	48.86
1918	48.38	37.83	30.37	33.88	55.17	57.03	45.44	50.45	31.37	26.15	50.71	47.51
1919	44.69	40.45	39.50	38.22	60.69	57.68	55.21	54.66	34.96	30.05	61.32	57.14
1920	62.69	43.06	47.67	40.95	64.58	64.37	64.91	58.50	35.33	32.27	67.30	64.88
Aver.	38.12	28.39	28.97	26.46	41.30	42.60	36.69	39.06	24.72	21.20	40.81	42.01

Another conclusion is that the general information possessed by the purchaser of such feeds, on which he bases the relative prices he wishes to pay, is fairly accurately measured by the digestible protein and productive energy. In other words, the relation is quite close between the selling prices of such feeds and their feeding values as measured by chemical analysis and other investigations.

\* Table 7—Texas selling prices and calculated values per ton.

	1919	1920	1921	1922	1923 Jan.	1923 Apr.	1924 Jan.	Av.
Oats—price .....	\$ 51.00	—	—	—	\$ 38.80	\$ 40.00	\$ 40.00	\$ 42.45
Calculated value .....	32.96	—	—	—	27.76	29.27	26.40	29.10
Wheat bran—price .....	53.31	42.00	33.50	31.00	31.20	36.11	35.00	37.44
Calculated value .....	43.15	29.70	27.54	25.86	27.51	29.21	25.01	29.71
Milo chops—price .....	53.27	46.00	38.84	34.12	43.00	43.75	39.00	42.57
Calculated value .....	66.71	50.16	45.80	34.87	39.72	41.69	38.93	45.34
Wheat gray shorts—price ..	66.40	58.20	40.00	35.40	36.33	39.30	40.00	45.09
Calculated value .....	64.33	45.75	42.18	36.60	40.03	42.33	37.38	44.09
Rice bran—price .....	43.77	—	26.89	28.00	25.60	31.00	22.00	29.54
Calculated value .....	52.55	—	35.59	27.91	31.71	33.76	30.63	35.34
Rice Polish—price .....	69.41	—	40.60	30.00	33.50	34.00	32.00	39.92
Calculated value .....	66.66	—	45.98	33.90	39.50	41.42	38.92	44.40
Hominy feed—price .....	63.35	—	33.40	31.75	—	—	36.00	41.12
Calculated value .....	68.35	—	47.48	34.54	—	—	41.23	47.90
Cottonseed hulls—price ..	—	6.00	—	—	16.00	19.50	13.00	12.75
Calculated value .....	—	10.56	—	—	7.50	7.79	7.77	8.41
Alfalfa meal—price .....	—	—	—	—	35.20	35.00	33.00	34.40
Calculated value .....	—	—	—	—	19.91	21.17	17.93	19.67
Prairie hay—price .....	—	26.00	—	—	21.50	26.50	24.00	24.50
Calculated value .....	—	18.11	—	—	13.10	13.64	13.44	14.59

Table 8—Pennsylvania selling prices and calculated values per ton.

	1914	1917	1918	1919	1920	1921	1922	Av.
Wheat middlings—price ....	\$ 32.05	\$ 50.62	\$ 57.94	\$ 62.19	—	\$ 41.40	\$ 38.68	\$ 47.15
Calculated value .....	32.77	57.81	60.26	69.12	—	38.77	40.99	49.96
Beet pulp—price .....	27.12	40.67	54.23	56.00	65.76	45.84	41.80	47.43
Calculated value .....	25.16	51.66	52.89	59.19	46.81	27.27	27.66	41.52
Alfalfa meal—price .....	32.40	42.33	52.60	50.67	66.20	45.44	43.67	47.04
Calculated value .....	17.93	28.30	30.00	35.17	33.75	22.78	24.70	27.52
Wheat bran—price .....	28.80	42.85	45.50	52.55	59.02	38.94	32.65	42.19
Calculated value .....	22.96	38.01	39.99	46.44	42.99	28.33	30.41	35.59
Hominy feed—price .....	31.14	55.22	68.44	69.80	69.46	38.38	37.28	52.82
Calculated value .....	34.92	68.12	69.85	78.34	62.59	36.79	37.48	55.44
Gluten feed—price .....	30.13	48.26	58.39	67.92	74.48	46.00	42.59	52.54
Calculated value .....	37.21	59.93	63.32	73.92	69.85	46.67	50.37	57.32
Brewers grain—price .....	27.85	46.06	59.39	58.80	69.00	48.40	42.61	50.30
Calculated value .....	24.65	33.00	35.97	43.65	47.16	34.11	37.97	36.64
Cottonseed meal—price ....	34.56	51.95	64.84	72.20	85.13	51.35	58.48	59.79
Calculated value .....	41.53	54.39	59.49	72.47	79.29	56.97	63.52	61.09

### Selling Prices Nearly Equal to Calculated Values

Selling prices are slightly less than the calculated money values in case of hominy feed, corn gluten feed, corn germ meal, cottonseed meal, wheat flour middlings, or gray shorts, brewers grains, milo chops, rice bran, and rice polish. In the individual tables, fluctuations below and above the calculated prices are found with many of these feeds.

The differences are no doubt caused in part by local conditions, including freight rates, unfamiliarity with the feed, nearness to source of

Table 9—Indiana selling prices and calculated values per ton.

	Wheat Bran		Corn Gluten Feed		Corn Germ Meal		Cottonseed Meal		Hominy Feed Meal or Chops		Alfalfa Meal		Cottonseed Cold Pressed		Wheat Middlings.	
	Price	Calculated	Price	Calculated	Price	Calculated	Price	Calculated	Price	Calculated	Price	Calculated	Price	Calculated	Price	Calculated
1914	\$ 25.78	\$ 20.85	\$ 28.97	\$ 33.85	\$ 28.67	\$ 33.68	\$ 32.66	\$ 37.50	\$ 28.01	\$ 30.05	\$ 29.00	\$ 15.24	\$ 26.97	\$ 30.11	\$ 27.72	\$ 28.79
1915	27.49	21.65	29.00	35.10	29.12	35.06	31.61	38.68	29.96	31.41	29.40	15.77	27.61	31.21	29.37	29.96
1916	24.00	23.38	31.00	37.97	31.45	37.60	33.03	42.32	31.11	33.40	31.24	17.18	27.06	33.79	30.64	32.16
1917	27.91	23.16	29.69	37.44	31.50	37.78	39.02	40.67	30.29	34.20	30.00	16.74	27.75	33.26	30.86	33.26
1918	—	38.58	51.81	55.61	55.00	62.69	47.35	50.61	56.06	62.51	40.98	23.47	38.00	48.87	—	53.03
1919	—	39.82	59.94	63.10	63.33	68.04	60.33	62.04	—	—	59.00	27.29	46.25	55.70	—	57.76
1920	—	44.41	—	70.98	66.15	74.40	69.89	72.98	68.20	69.77	48.80	31.15	—	62.83	—	63.31
1921	—	46.10	—	74.62	70.15	74.94	72.50	81.63	66.71	67.49	57.62	33.44	—	66.32	—	64.01
1922	—	25.59	—	42.78	37.04	38.83	44.03	52.92	31.23	31.33	44.81	20.04	—	38.34	—	33.47
Average	26.29	22.26	38.40	43.85	45.82	51.45	47.82	53.26	42.69	45.02	41.21	22.25	32.28	38.82	29.65	31.79



supply, fluctuations in prices not equalizing in averages, and preference for certain feeds.

If we take all these facts into consideration, we can safely conclude that the digestible protein and productive energy certainly represent the prime factors in the values of the feeds mentioned, and may properly be used for comparing them.

Possibly, instead of using prices of one protein feed and one carbohydrate feed to calculate the price of digestible protein and productive energy, it would be better to calculate from two or more pairs of feeds, and use the averages.

### Feeds for Which the Selling prices are Greater than the Calculated Money Values

The selling prices of oats, wheat bran, alfalfa meal, cottonseed hulls, and prairie hay are greater than the calculated money values. The differences are least for wheat bran.

These differences may be partly due to preference for wheat bran as a feed for dairy cows and for oats as a horse feed, and to preference for alfalfa meal for use in mixed feeds, as well as other causes. The bulk or volume may be also an important factor with alfalfa meal, cottonseed hulls, and prairie hay.

While prices of alfalfa hay are constantly higher than the calculated values in the Trade Commission wholesale prices, the differences are much smaller than the differences with Indiana, Pennsylvania, and Texas retail prices. The farm prices would be still lower than the wholesale prices. There is thus less difference in the prices of these bulky feeds at the great wholesale markets, or on the farm, than at the retail market. This is probably due in large part to the cost of transporting and handling feeds containing small amounts of feeding utility in proportion to weight. Thus while the retail purchaser of hays and fodders may pay a price for bulk or volume, the farm price, or the price received by the seller, may be less than the price based on protein and productive energy. This point requires study in connection with farm prices.

### Cost of Bulk

The excess of the selling prices over the calculated prices of several feeds is given in Table 10. Part of this excess may be due to other factors than bulk, as pointed out above. The difference is small with Trade Commission wholesale prices. Oats and wheat bran are more concentrated feeds than alfalfa, cottonseed hulls, or prairie hay.

We have taken as a measure of bulk in 100 pounds, the difference between 100 and the sum of the productive energy E and the moisture M.

$$100 - (E + M) = B \text{ Equation 10.}$$

The energy value of the protein is included in the productive energy. By taking D, the excess in selling prices over calculated values in cents per ton, the cost of one pound bulk R is calculated by Equation 11.

$$D \div 20B = R \text{ Equation 11.}$$



Table 10 contains the cost of a pound of bulk calculated by the above method. Wide differences occur. The price of bulk in oats is excessive, no doubt due to demand for oats as horse and mule feed. The wholesale price of bulk in wheat bran and alfalfa meal is practically the same. The retail price of bulk in wheat bran and alfalfa meal is three or four times as much as the wholesale price, and the cost is less for the more concentrated wheat bran. This bears out the theory that the price of bulk is largely due to transportation and handling expenses. The retail price of bulk in alfalfa hay and prairie hay is quite different. The price of bulk in wheat bran is somewhat lower, while it is quite low in cottonseed hulls.

Table 10—Average excess of selling price over calculated values, and price of a pound of bulk.

	Excess selling price per ton				100 pounds Bulk in	Prices of one pound of bulk in cents.			
	Wholesale	Indiana	Penn.	Texas		Wholesale	Indiana	Penn.	Texas
Oats .....	\$ 9.73	—	—	\$ 13.35	30	1.61	—	—	2.23
Wheat bran .....	2.51	4.03	6.64	7.73	40	0.31	0.50	.83	.97
Alfalfa meal .....	3.52	18.96	19.52	14.63	50	0.35	1.90	1.95	1.46
Cottonseed hulls .....	—	—	—	4.34	75	—	—	—	.29
Prairie hay .....	—	—	—	9.93	60	—	—	—	0.83

It is difficult to select any one feed for use in calculating the approximate cost of bulk. Oats and wheat bran are concentrates, though bulky. Alfalfa meal sometimes has an excessive price, prairie hay varies greatly in the amount rejected by the animal, and cottonseed hulls alone do not seem suitable. It would probably be best to use the average of three roughages well known in the locality. In Texas, the averages for Johnson grass hay, alfalfa hay, and cottonseed hulls might be used.

There is no doubt that bulk is a factor in the feed utility of such feeds as wheat bran and oats, and all roughages such as alfalfa hay, when purchased at retail. On the farm where roughages are grown, bulk has no value.

### Other Factors of Feed Utility

The three main factors of feed utility are productive energy, digestible protein, and bulk. Other factors no doubt take part. These would include vitamins, nature of proteins, and amount and nature of ash. Our present knowledge does not justify us in attempting to assign values to any of these. Investigations concerning their nature, use, and value in animal feeds need to be pushed further before such calculations are justified.

### Feed Cost of Hogs

The feed cost of meat and milk may be calculated from the prices of the protein and productive energy, on the assumption of requirements for production. The requirements assumed for this purpose are given in

Table 11. These are ideal conditions. Under ordinary conditions, the cost may be greater. These calculations are made for the purpose of illustrating the use of the method, and not for the purpose of comparing costs and prices.

Table 11—Estimated requirements for production.

	Digestible Protein lbs.	Productive Energy, Therms
Swine for 1 pound gain.....	.15	4.2
Steer for 1 pound gain.....	.40	6.5
Cows—10 lbs. milk.....	.90	7.6
Cows—20 lbs. milk.....	1.60	10.0
Cows—30 lbs. milk.....	2.10	12.3
Cows—40 lbs. milk.....	2.60	14.7
Milk, per quart, (cow giving 10 lbs.).....	.18	1.52
Milk, per quart, (cow giving 20 lbs.).....	.16	1.00
Milk, per quart, (cow giving 30 lbs.).....	.14	.82
Milk, per quart, (cow giving 40 lbs.).....	.13	.74

Table 12 contains the calculated cost of feed and the selling prices of hogs and cattle. The prices of digestible protein and productive energy are those given in Table 3. The farm prices are taken from the Year-book of the U. S. Department of Agriculture.

Table 12—Selling price and feed cost of digestible protein and productive energy for hogs and cattle in cents per pound if feed was purchased at prices given in table 13.

	Farm Price Hogs	Feed Expense Hogs (U.S.)	Average Chicago Price Cattle	Feed Expense Cattle (U.S.)
1913.....	7.16	5.57	8.21	8.76
1914.....	6.67	6.24	8.65	9.80
1915.....	6.02	6.46	8.43	10.24
1916.....	8.76	7.38	9.33	11.61
1917.....	15.73	15.02	11.67	23.25
1918.....	15.82	14.61	14.60	22.61
1919.....	12.66	14.38	15.45	22.62
1920.....	8.90	15.15	13.32	23.89
1921.....	6.52	4.90	8.16	8.33
Average.....	9.81	9.97	10.87	15.68

If we compare the farm prices with the wholesale feed cost, we find the feed cost is slightly lower, excepting in 1920. There is usually a margin between the wholesale feed-cost of hogs, and the wholesale price of hogs. This margin allows for care, interest and other expenses, and these calculations confirm statements generally made that the feeding of animals is one method of marketing feed. In 1920, the farm price of hogs dropped greatly below the wholesale feed cost and the feeders lost money.

If we examine the feed expense of hogs when feeds are bought at retail prices—Texas prices—we find that the feed expense is **greater** than the selling price in all cases. The hog grower cannot afford to buy much feed at the prices given, though he may afford to purchase some supplementary feed. The difference between the retail feed-expense of hogs

and the farm prices of hogs seems usually to afford an excellent margin of loss.

### Feed-Cost of Cattle

The average Chicago prices of cattle are less than the wholesale feed-cost of cattle. The difference would be still greater for farm prices. The differences were especially great during the war period. Cattle growers cannot afford to pay these wholesale prices for feeds excepting for finishing periods, when there would be a margin between the selling price of a pound of the finished cattle, and the cost of a pound of the animals bought to be fattened.

The differences between the Chicago price of cattle and the retail expense of the feed in Texas are of course greater than when the wholesale prices are taken.

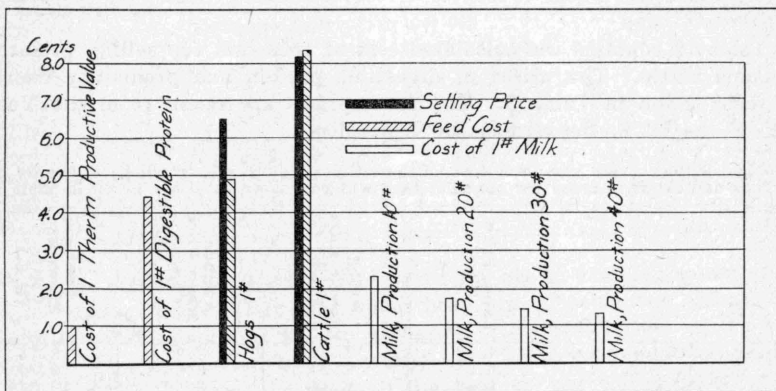


Figure 5—Illustration of use of the method.—Relation of selling price of farm animals to expense for feed calculated from requirements for digestible protein and productive energy and wholesale calculated prices of these feed utilities and cost of milk for different production by cows.

It has already been stated that a committee of the American Society of Agronomy estimates that over one-half the feed of cattle is furnished by pasturage, and that pasturage costs only about one-fourth as much as harvested forage.

The prices of cattle must depend at present upon the utilization of low-price range feeds, which are harvested by the cattle themselves, and so have a farm cost much lower than the prices here given. The growing of cattle is a method of marketing bulky feed, as has been frequently pointed out by agricultural writers. The low price of cattle compared with the cost of feed can continue only as long as there is a good supply of low-cost range feed to be marketed in the form of cattle. The larger the proportion of the feed of cattle which comes from purchased feeds, the higher must be the selling price of the cattle in order to make a profit.

No cost is to be assigned to bulk or volume for feed for cattle, except where roughage must be purchased for finishing cattle. For most of the

cattle sold, bulk or roughage must have a negative value, that is, the productive energy and digestible protein must cost less in bulky feeds than in concentrates, otherwise cattle could not be sold, at the prices received. The cattleman must make a living out of his business, or he cannot continue in it.

### Feed Cost of Milk

The estimated feed cost of milk with cows of different capacity, with feed purchased at wholesale prices, is given in Table 13.

The feed cost of milk is only one factor which enters into its cost. The labor of caring for the cows and the expense of distribution are especially high for milk. The margin between the feed expense of milk and its selling price must be wide.

Table 13—Wholesale feed cost digestible protein and productive energy with cows of different capacity, in cents per pound of milk if feed is purchased at prices given.

	Prices of Productive Energy per Therm	Prices of Digestible Protein per Pound	Feed Expense			
			10-lb. Milk	20-lb. Milk	30-lb. Milk	40-lb. Milk
1913 .....	1.296	.828	2.12	1.43	1.18	1.07
1914 .....	1.453	.887	2.37	1.59	1.32	1.19
1915 .....	1.486	1.458	2.52	1.72	1.42	1.29
1916 .....	1.719	1.083	2.81	1.89	1.56	1.41
1917 .....	3.577	0	5.44	3.58	2.93	2.65
1918 .....	3.478	0	5.29	3.48	2.85	2.57
1919 .....	3.345	2.204	5.48	3.70	3.05	2.76
1920 .....	3.514	2.634	5.82	3.94	3.25	2.94
1921 .....	1.007	4.461	2.33	1.72	1.45	1.33
1922 .....	1.010	6.005	2.62	1.97	1.67	1.53

The table shows the increase in the feed cost of milk during war conditions, and the decrease in 1921. There is also a great difference in the cost of milk with low-producing cows as compared with high-producing cows. The feed cost of milk for cows giving 40 pounds of milk is about one-half the cost with cows giving 10 pounds. Table 14 contains similar figures for retail Texas prices, which are of course greater than the wholesale prices used in Table 13.

Table 14—Texas Digestible protein and productive energy, feed cost of cattle, hogs, and of milk with cows of different capacity, in cents per pound if feed is purchased at prices given.

	Price One Pound Digestible Protein	Price Productive Value Therms	Feed Expense					
			Hogs	Cattle	10-lb. Milk	20-lb. Milk	30-lb. Milk	40-lb. Milk
1907..	.069	1.516	6.32	9.88	2.32	1.53	1.25	1.13
1910..	.263	1.805	7.62	11.84	2.79	1.85	1.52	1.37
1913..	0	1.825	7.67	11.86	2.77	1.83	1.50	1.35
1918..	0	4.252	17.86	27.64	6.46	4.25	3.49	3.15
1919..	2.246	3.787	16.24	25.51	6.16	4.15	3.42	3.09
1920..	0	3.018	12.68	19.62	4.59	3.02	2.47	2.23
1921..	.257	2.730	11.50	17.85	4.20	2.77	2.27	2.05
1922..	3.391	1.725	7.84	12.70	3.26	2.29	1.91	1.73
1923..	2.454	2.142	9.36	14.90	3.70	2.53	2.10	1.90

The cost of bulk or volume was not included in the feed cost of milk. This is an item to be considered for many dairymen, who have to buy roughages. When milk is produced on farms, producing their own roughage, there is probably no expense to be assigned to bulk or volume. Since pasturage is a cheaper source of feed than concentrates, the feed cost of milk may be decreased by using pasturage.

The object of calculating these feed costs is to illustrate the use of the method.

### Conclusions

A method is given for calculating the prices of digestible protein and productive energy in feeds. The relative prices of digestible protein and productive energy vary considerably from time to time.

The money values of concentrates calculated from the prices of digestible protein and productive energy are closely related to their selling prices.

Feeders have a fairly accurate knowledge of the relative utility of feed, and this is a large factor in establishing their market prices.

Bulk or volume has a cost when roughages are purchased.

The farm value of digestible protein and productive energy in roughages may be less than in concentrates, especially when the roughages are harvested by grazing.